UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Agricultural Engineering

PROSPECTUS ON

RURAL ELECTRIFICATION IN THE TENNESSEE RIVER BASIN

By

George W. Kable, Rural Electrification Specialist

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Contents

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INTRODUCTION

In a report on the agricultural phases of the Tennessee Valley Authority Act, made by the Department of Agriculture in May, 1933, a number of problems were stated as requiring consideration in the formulation of plans for development of the Valley. In regard to rural electrification the report states:

> One of the principal purposes of the proposed development is the production of electrical power for the use and benefit of the people within the Tennessee Basin and, as mentioned specifically in the Act, for use on farms. In order to promote and encourage the fullest possible use of electric light and power on farms it will be necessary to study the possible agricultural uses of electricity adaptable to the area, to conduct research in order to develop new and additional uses, and to develop plans and methods for the feasible and economic distribution of electric power in rural areas. . . .

In the same report the Department of Agriculture suggests a specific program of action, which includes projects relating to use of electric power in agriculture and small industries as follows:

a. Development of plans, methods, and technique for the early transmission and use of electricity on existing farms and in villages and small industries.

b. Study the adaptation of present uses of electricity to the farms and small industries of the area, and establish demonstrations of such uses.

c. Conduct research in "the wider and better use of electric power for agricultural and domestic use", and "for small or local industries" giving particular attention to the effect of new and more extended uses of electricity on the organization and management of farms and the economic and social welfare of the rural population.

As a basis of developing a practical program of research and development in use of electricity on farms and in rural districts in the Tennessee River basin, this prospectus has been prepared. Available data bearing upon the present and probable future development of agriculture in the basin have been collected and summarized; the progress made in the use of electricity on farms and in rural districts in the United States and other countries has been outlined; the elements that must be considered in setting up a program of rural electrification in the Valley are discussed; and a program of action is tentatively suggested.

AUTHORITY

Section 10 of the Tennessee Valley Authority Act, approved May 18, 1933, makes the following provision:

** In order to promote and encourage the fullest possible use of electric light and power on farms within reasonable distance of any of its transmission lines the board in its discretion shall have power to construct transmission lines to farms and small villages that are not otherwise supplied with electricity at reasonable rates, and to make such rules and regulations governing such sale and distribution of such electric power as in its judgment may be just and equitable: PROVIDED FURTHER, That the board is hereby authorized and directed to make studies, experiments, and determinations to promote the wider and better use of electric power for agricultural and domestic use, or for small or local industries, and it may cooperate with State governments, or their subdivisions or agencies, with educational or research institutions, and with cooperatives or other organizations, in the application of electric power to the fuller and better balanced development of the resources of the region.

PART I - THE TENNESSEE RIVER BASIN

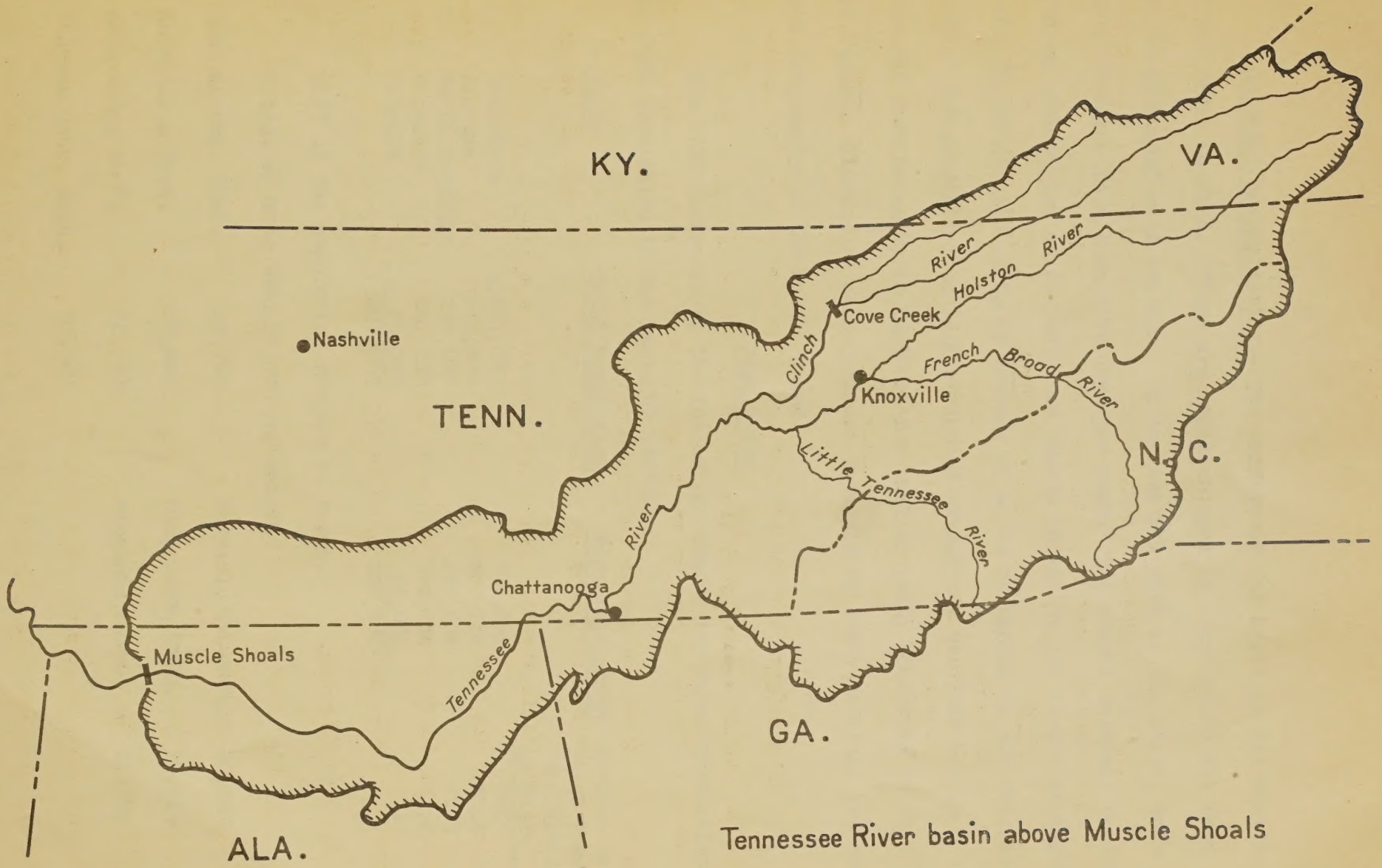
Physical Features

Area.- The Tennessee River Basin above Muscle Shoals contains 19,712,000 acres, distributed in five States as follows:

State	Area in Acres	Percent of Total Area
Tennessee	9,791,000	49.7
North Carolina	3,560,000	18.1
Alabama	3,391,000	17.2
Virginia	2,039,000	10.3
Georgia	931,000	4.7
	19,712,000	100.0

Topography.- The eastern portion of the watershed lies in the rough mountainous country of the Cumberland Plateau and Blue Ridge Mountains. Forty or more of the mountain peaks are higher than 6,000 feet. Slopes are steep and stream courses short with very little level land either on the mountain tops or in the valleys. In the central eastern part of the basin lies the Appalachian Valley containing many long narrow valleys and low ridges with a general elevation of 1,000 feet. The section of the basin from Chattanooga to Muscle Shoals is a gently rolling region with elevations from 1,000 to 500 feet and with rougher country at the outer margins.

Soils. Fertile limestone soils predominate in the central part of the Basin, in northern Alabama and a considerable portion of the Appalachian Valley. Rich alluvial soils cover the flood plains of the stream valleys. Many of these alluvial areas may be flooded by backwater from proposed power and navigation dams. The soils of the Cumberland Plateau at the north and east are loams, sandy loams and clay, with light textured, sandy soils predominating in the Blue Ridge region.



Tennessee River basin above Muscle Shoals

Climate; Precipitation.- The climate of the agricultural section of the basin is mild. There are rapid changes in temperature but very little prolonged cold weather. In the central part of the basin, snow cover averages less than five days per year. The annual rainfall varies from an extreme low of 29 inches at Muscle Shoals to 120 inches at highlands, North Carolina with an average of 44 to 55 inches in the central basin. The precipitation is distributed throughout the year but is heaviest from December to March with a smaller peak, occurring in July and August. Floods are caused almost entirely by heavy rainfall and occur most frequently in the months named.

Population

The 1930 Census gives the following figures for total population and farm population in the Basin by States:

State	Total Population	Farm Population	Percent of Total Farm Population in Basin
Tennessee	1,021,000	439,861	47.4
Alabama	292,000	207,718	22.4
North Carolina	290,000	142,608	15.3
Virginia	231,000	104,636	11.2
Georgia	53,000	34,551	3.7
	1,887,000	929,374	

Half of the population resides on farms.

Cities of more than 10,000 population:

Chattanooga, Tenn.	119,798	Bristol, Va.-Tenn.	20,845
Knoxville, Tenn.	105,802	Kingsport, Tenn.	11,914
Asheville, N. C.	50,193	Florence, Ala.	11,729
Johnson City, Tenn.	25,080		

Mineral and Timber Resources

The area is well supplied with minerals, the mining and transportation of which constitute some of the industries of the region. The availability of these raw materials also adds to the attractiveness of the region for new industries. Army engineers have reported the following mineral assets:

Chief Minerals of the Area	Production in 1926	Mineral Reserves
Coal	11,991,000 tons	1,835,000,000
Limestone	2,152,000 tons	Inexhaustible
Sand, gravel	1,643,000 tons	"
Zinc ore	822,000 tons	45,000,000
Phosphate rock	460,000 tons	92,400,000
Iron ore	166,600 tons	169,047,000
Marble	72,000 tons	Large

The commercial varieties of timber are as varied as are to be found on any equal area in the United States. They include ash, basswood, beech, birch, buckeye, red cedar, chesnut, cherry, elm, black gum, hemlock, hickory, maple, sugar maple, red, scarlet, chesnut, spanish and white oak, white and yellow pine, yellow poplar and spruce. The total area classified as forest land embraces 13,073,000 acres of which 1,346,000 acres are in State and Federal ownership. In 1928, 505 sawmills in Tennessee reported a total cut of 530,300,000 board feet; and this is less than 20 per cent of the number of mills in operation in 1909. Only a relatively small amount of old growth timber remains and this is largely in inaccessible locations. The 1930 Census, however, reports 328 wood producing establishments in 28 counties in Georgia, North Carolina and Tennessee, employing 11,098 workers or 21.6 per cent of the workers employed in all industries in that area. The Forest Service estimates that with adequate fire protection and even crude forestry management the 13,000,000 acres of timber land would eventually produce an average of 1,500,000,000 board feet of saw timber per year.

Industries

Industries include agriculture, lumbering, mining and manufacturing of furniture, cotton goods, and tobacco.

The total number of industries reported in the 1930 Census in 59 Basin counties for which statistics were available was 1,734 employing 91,563 wage earners and involving products valued at $385,992,000.

The availability of raw materials, power, transportation, and labor makes the Basin an attractive location for further industrial development. The combination of timber, mineral, agricultural and power resources suggests unusual possibilities for many small industries or for experiments in the decentralization of larger industries.

Agriculture

Agriculture is the chief industry of the Tennessee River Valley. One half of the population, or more than 900,000 persons reside on the 173,000 farms in the area. The farms at present embrace over 12,000,000 acres of the total basin area of 19,712,000 acres. Approximately two-thirds of the farm lands have been cleared and the remaining one-third are classed as woodlands.

Out of the 7,864,000 acres of cleared land, 1,539,000 have either been abandoned or listed as sub-marginal, and it is estimated that an additional 385,000 acres will eventually be abandoned. This would leave approximately 10,000,000 acres in farms, of which 6,000,000 acres would be truly agricultural land and 4,000,000 farm woodlands.

A large part of the basin is adapted to general farming. Bluegrass thrives in the limestone areas in central and western Tennessee and Kentucky and livestock and dairy farming predominate. That part of the watershed in southwest Virginia is a noted beef cattle producing area. Hay, grain, tobacco, cotton, potatoes, fruits and berries

are the main crops of the basin. Cotton growing is limited to northern Alabama and southern Tennessee.

Farms within the Basin.1/- The 1930 Census lists 229,982 farms in 95 counties wholly or more than 50 percent within the basin. (See Appendix A.) The average size of the farms is approximately 73 acres. Fifty-nine percent are operated by owners and 41 percent by tenants. Buildings are generally poor and the homes are decidedly lacking in modern conveniences. Most of the farming is done with two-horse or smaller machines and there is evidence on many farms of the need of reorganization and of improvement in methods. A large number of the farms are of the self-sufficing type with the operators spending part time at other occupations.

Possible Future of Agriculture.- Much of the farming territory which might be served electrically is suited to more intensive cultivation - truck and berry growing, poultry raising, and dairying. The trend of agriculture of the region will probably depend considerably upon the industrial development. New industries with increasing population would improve local markets and stimulate a shift to more intensive types of farming. There is also a possibility of an increasing number of self-sufficing, part-time farms whose operators will be engaged for part of the year in other industries. It is safe to assume that some such change will take place as rapidly as electric service becomes available to the farms. Should industrial development

1/ Statistics previously given included only that portion of the Basin above Muscle Shoals. Remaining statistics include the entire water shed as given on the map of the Basin prepared by the U. S. Geological Survey in June 1933.

not follow the installation of power plants, the power distribution systems would no doubt also be limited.

Electric Service in the Basin

In 1929 2/ there were in the Tennessee River Basin 23 hydro-electric plants of 370 kilowatts or over, totalling 413,470 kilowatts. There were also 20 smaller hydro-electric plants with a total installed capacity of 3,000 kilowatts, and steam-electric plants with capacities totalling 179,880 kilowatts, making the total of installed power in the basin nearly 600,000 kilowatts.

It is estimated by the U. S. Army engineers that the ultimate development of the Tennessee River and its tributaries with auxiliary steam plants will provide approximately 4,000,000 firm horsepower.

Plate 182 of the Report on the Tennessee River 2/ lists 73 public utility companies within transmission distance (350 miles) of the proposed hydro-electric developments and gives the locations of generating plants and transmission lines belonging to these companies. There are a number of transmission systems within the basin, mainly between generating plants and industrial or population centers. The coverage is relatively small.

The Government power plant at Dam No. 2, Muscle Shoals, has an installed capacity of 184,000 kilowatts. The amount of power developed between September, 1925, and 1929 when the engineers' report was made, averaged 47,200 kilowatts.

2/ House Document 328, 71st Congress, 2nd session.

Present Farm Service.- Out of 229,982 farms in the Basin, 10,178 or 4.4 percent were lighted with electricity, according to the 1930 Census. (See graph following page 16 .)This is less than one-third of the 14.3 per cent of farms in the United States having electric lights, and includes lighting by means of individual plants as well as central station service. The number of farms in the Basin receiving service from central stations was 6,902 or 3 per cent of the total. These farms paid to power companies for service in 1929 285,769 or $41.40 per farm. Balancing existing rates against consumption, the average yearly consumption per farm was approximately 460 kw-hrs. Since in most similar territories there are a few large users of farm power and many small ones, it may reasonably be assumed that 80 per cent of the farms are using not more than 380 kw.-hrs. per year, or only slightly more than the minimum which must be paid for service.

The following table, quoted from Electrical World of September 10, 1932 (p. 340) shows the increase in rural business in a group of six southeastern States from 1929 to 1931. It shows not only good percentage of increase in use, but an annual use per farm of about 1,200 kw.-hrs., a figure which may reasonably be expected to be reached within a short time in similar territory.

Increase in Rural Business -

Six Southeastern States

Year	Number of farms	Total annual kw.-hr. sales	Annual kw.-hr. sales per farm customer	Increase in annual kw.-hr. sales per farm	Per cent increase over preceding year
1929	13,228	10,899,576	620		
1930	17,405	16,112,513	930	110	11.3
1931	19,093	21,777,818	1,140	210	23.0

Rural Rates.- On the assumption of a monthly use of 100 kw.-hrs. of energy, farmers in the Tennessee Basin are paying an average rate of 9 cents per kw.-hr. for electricity. This cost is based on rates of six companies ranging from 4-3/4 cents to 12 cents per kw.-hr. and assuming 5 farmers per mile of line and line costs at $1,000 per mile. (See appendix B.) Rates for lighting only would be considerably higher.

PART II.- DEVELOPMENT OF RURAL ELECTRIFICATION IN THE UNITED STATES AND IN FOREIGN COUNTRIES

Rural Electrification Investigations

Prior to the World War very few farms in the United States had electric service from central stations. A genuine interest in electric service was evidenced by farmers, however, in their purchases of farm lighting plants. In 1917 there were more than 160 manufacturers of such plants in the United States and the number was increasing. The War practically stopped the manufacture of individual plants. After the War there was a greater demand for central station service with the opportunities for the use of larger power units which it presented. The demand for this service was met very reluctantly by most utility officials, who saw nothing but loss in the existing small load for lighting and appliances in rural territory having only perhaps 5 customers per mile of line. There were numerous complaints from farmers because of the high service or construction charges and the rural rates of utilities.

In September, 1923, an investigation was undertaken in Minnesotta to determine the feasibility of farm service from the standpoint of both the farmer and the utility. In this investigation there was

cooperation between the electric utilities, a group of farmers, and the State University. The experiment was given wide publicity. It focused attention on the possibilities of using electricity for many purposes other than lighting the farm, and in a manner which might result profitably to both the farmer and the utility.

Committee on the Relation of Electricity to Agriculture

In 1923 the National Committee on the Relation of Electricity to Agriculture (C.R.E.A.) was formed through the cooperative action of the American Farm Bureau Federation and the National Electric Light Association. The Committee membership included representatives from the following organizations:

American Farm Bureau Federation
American Home Economics Association
American Society of Agricultural Engineers
General Federation of Woman's Clubs
Individual Plant Manufacturers
National Association of Farm Equipment Manufacturers
National Electric Light Association (Now Edison Electric Institute)
National Electric Manufacturers Association
National Grange
State Project Directors
U. S. Department of Agriculture
U. S. Department of Commerce
U. S. Department of Interior
Members-at-Large

The purpose of this Committee was to gather and disseminate facts regarding farm electrification. Under the leadership of the National Committee, similar committees were organized in 25 States. It was the primary function of these State committees to organize and support an investigation program relating to the use of electricity in agriculture and to disseminate the information obtained. The responsibility for conducting the investigations was placed by the State committees in the hands of officers of the State agricultural colleges or experiment stations.

In order to further stimulate the possibilities of using electricity on the farm, the National Rural Electric Project located near Washington at College Park, Md., was established in 1928. Investigational work has been conducted both in the laboratory and on the farm.

Sales Efforts of Utilities.- Almost simultaneously with the establishment of investigational work in rural electrification, some of the power companies employed agricultural engineers to look after their rural territory. Part of these men devoted their time to strictly educational work while others combined educational work with power and equipment sales. In most cases the work headed up in the sales department of the utility. In 1930 there were approximately 1,000 rural service men employed by power companies. Some of them had had experience with the different state projects. Others were recent graduates from agricultural colleges. The majority, however, were men who had been transferred from some other branch of the utility organizations. Through their aid the rural load was built up considerably and they assisted in the problems of handling public relations. In the past year a large number of these men have either been discharged or transferred to sales or other activities.

While rural service men have done much to introduce electricity to the farm, they have generally expressed a desire for assistance with an educational program to stimulate farm demand for uses which have been found desirable by investigators. Apparently something more is needed than to show that electricity will perform an operation at reasonable cost. The farmer must be shown how that operation can be fitted into his management plan advantageously.

Other Rural Service Organizations.- A Rural Lines Committee was established by the National Electric Light Association (N.E.L.A.) in 1921. Later the name was changed to Rural Electric Service Committee. This Committee had representation from the utilities in all sections of the country. It was directed to study, investigate and make recommendations for the solution of the problems involved in rendering electric service to the farmer. A number of reports were issued and the Committee worked in close cooperation with the C.R.E.A.

With the disbanding of the N.E.L.A. and organization of the Edison Electric Institute, the former committee work was discontinued. A sub-committee on rural sales under the general sales committee of the new organization is contemplated but has not been named.

Publications on Uses for Electricity in Agriculture

Some 300 publications on many subjects relating to rural electrification have been issued by the National and State Committees, the National Rural Electric Project, State Experiment Stations, Agricultural Extension Service, utilities and manufacturers. Two of the larger of these publications give a rather complete story of the development of uses for electricity on the farm and of research work under way. C.R.E.A. Bulletin No. 1 (332 pp.) Vol. VII gives experimental and use data on many applications of electricity on the farm and contains a partial bibliography of the more important publications. C.R.E.A. Vol.VI. No. 1 (79 pp.) describes briefly 211 C.R.E.A. investigations, 493 active projects in colleges, universities, and the United States Department of Agriculture related to rural electrification, 118 undertakings of an investigational nature by utilities and commercial concerns, and 39

investigations in private and other laboratories. Eighty-five suggestions for new studies are also included.

There have been listed 227 uses for electricity on the farm and 190 uses in rural industries. 3/ While these lists contain some duplications, they indicate something of the possible extent of the use of electricity in rural territory.

Essential Factors for Low Costs and Profitable Use

Early in the studies of farm electrification the many investigators came to similar conclusions regarding the development of rural service. These conditions were that the key to farm electrification is lower rates and greater use. One is dependent upon the other.

In practically all rate structures of both privately and publicly owned utilities, whether for rural or urban application, the average rate paid per kw.-hr. for service decreases with increased use. This is a commonly accepted principle of barter. The more you buy, the less the price per unit. Two farm customers on opposite sides of a road, and on the same line and rate, might pay average rates of 3 ¢ and 12¢ per kw.-hr. because of differences in amounts used. With guarantees of greater use, power companies have assumed larger and larger proportions of the original line costs, in some cases building the lines without making assessments in excess of urban rates or imposing other conditions.

3/ C.R.E.A. Bulletin Vol. III, No. 3, June 1927.

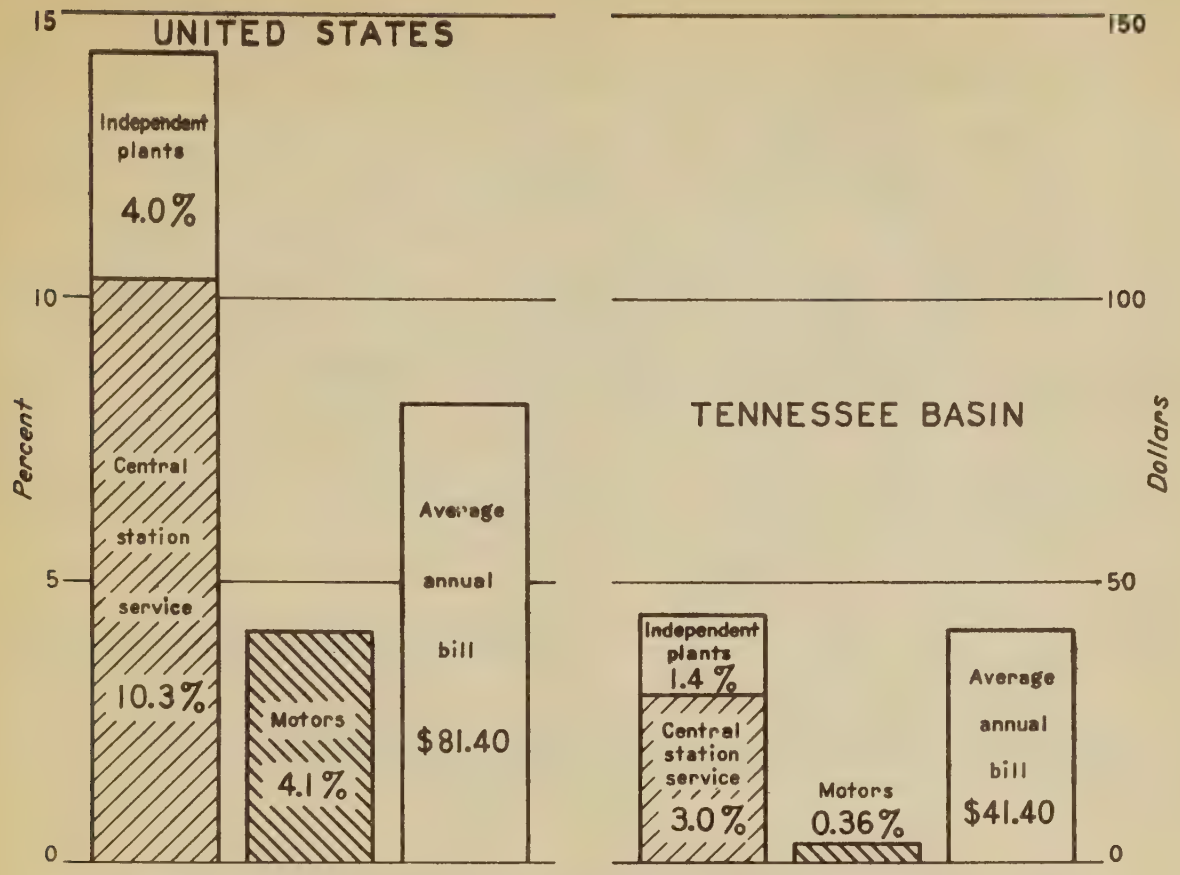
The fact of rural costs is that distribution to a few customers per mile in order to break even must carry on overhead for interest, depreciation, upkeep, line losses, accounting, etc. which is larger per customer than in more densely populated areas. The difference has been made up in excess charges where it has not been compensated for by greater use.

Returns for Fear and for Faith

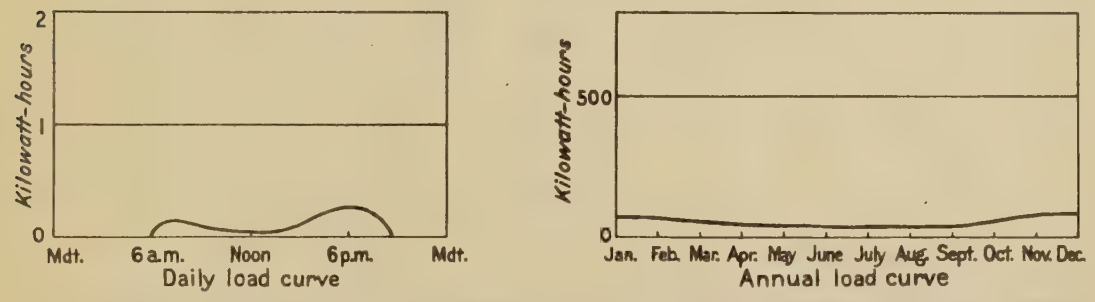
There is evidence that many power companies have paid too much attention to accounting technicalities and immediate monthly balance sheets in the making of their rural rates and line extension policies, and as a result have discouraged farm electrification. Without any very profound attempt at developing the immense potential farm load, but with a good rate and some attention given to educational promotion, the annual farm consumption has gradually increased to the point where some companies are finding it unnecessary to impose a service charge or exact a guarantee. This is the case, for example, in recent line extensions in the Roanoke territory of the Appalachian Electric Power Company. This company has learned that the farm use is either in excess of or so close to the specified minimum that the extra bookkeeping required and sales resistance engendered by a guarantee is not warranted. The Appalachian farm rates (Appendix B) are low in comparison with those of most companies, reaching the 4 cent block after paying $1.50 for the first 25 kw.-hr. and being 2 cents per kw.-hr. after paying $10.25 for the first 300 kw.-hrs.

Characteristics of the Farm Load

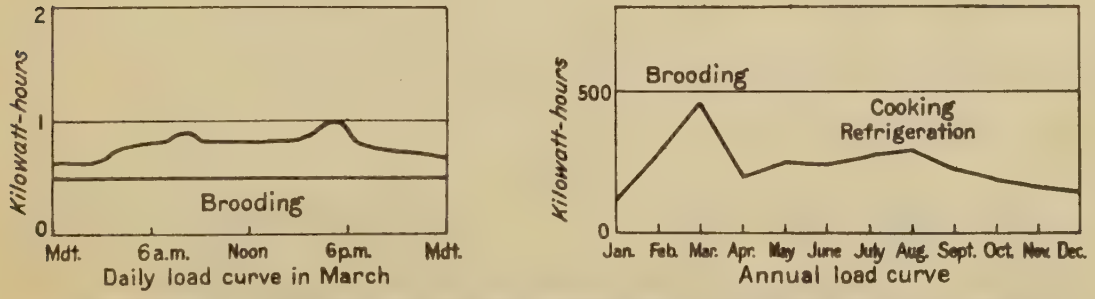
The character of the farm load has been changing, particularly where companies have placed no penalties on increased demand and where rates have been low enough to encourage use. A few typical daily and



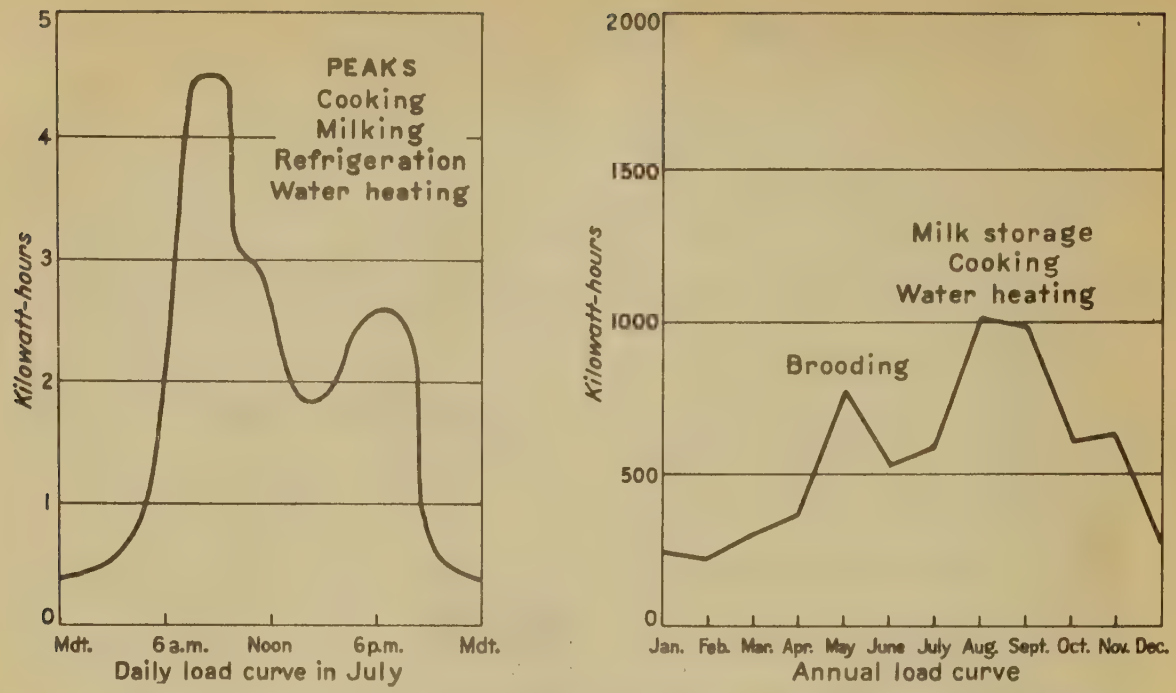
Comparison of Tennessee River Basin with entire United States in percent of farms using farm lighting plants, central station service, and farm motors in 1930, and in average amount paid to power companies annually by farm patrons in 1929. (Census figures.)



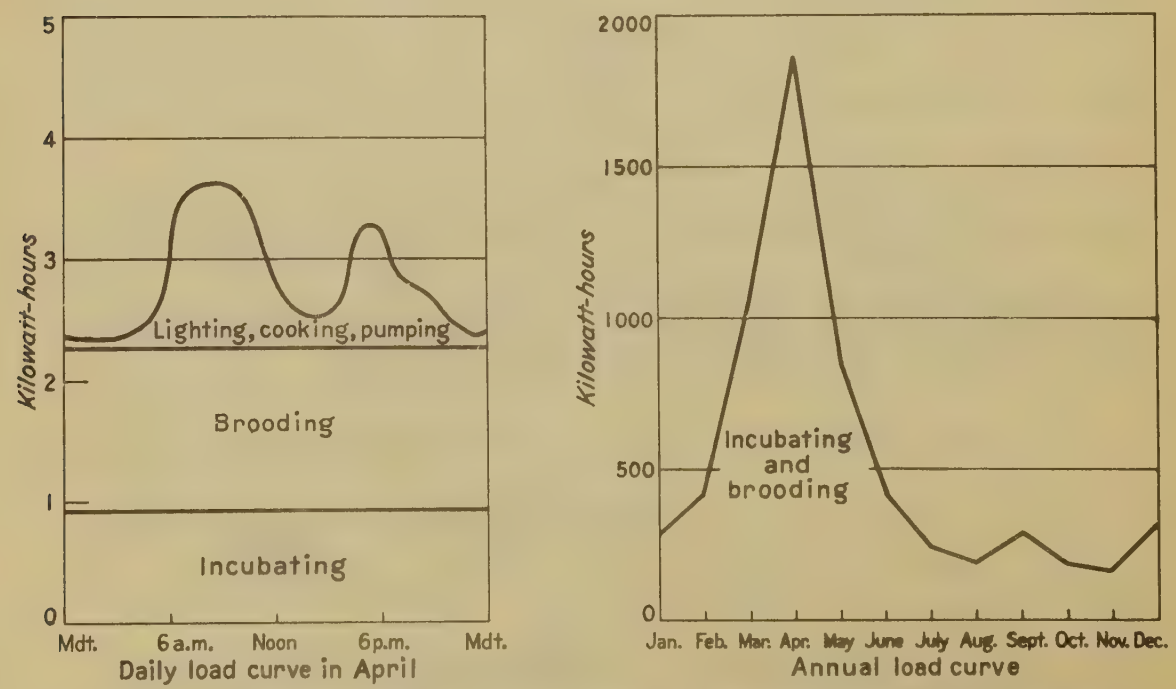
Typical farm load curve where rates are high and penalty attaches to a higher demand. Consumption frequently is held to minimum charges. Lighting constitutes the predominating load. A water pump and small appliances may be in use. Average monthly consumption ranges from 30 to 70 kw.-hrs. Education and better rates change these curves.



Load curves on a 97-acre poultry farm in Maryland, 1930. Electricity was used for brooding, lighting the laying houses, shelling and cracking corn, cooking, refrigeration, lights, and house-hold conveniences. Lowest block in the rate was 4 cents per kw.-hr., but considerable educational work had been done. Average use was 245 kw.-hrs. per month.



Load curves for a 25-cow dairy in Maryland using electricity for milk cooling, milking machine, water heating, utensil sterilization, water pumping, feed grinding and mixing, brooding, farm shop, cooking domestic refrigeration, and for many appliances and miscellaneous farm operations. Record for 1930; average monthly consumption 540 kw.-hrs.



Load curves for a poultry farm with a commercial hatchery. Electricity was used for incubation, chick storage, brooding, lights on hens, sun lamp on chicks, flood lighting, water pumping, poultry-water warming, cooking, refrigerating, and the usual appliances. Consumption averaged 526 kw.-hrs. per month. Note that the peak demands on dairy farm and poultry farm occur at different times of year and would tend to level the combined-use curve.

annual load curves for farms of different types and under different conditions are given following page 16.

It must be understood that there is a wide variation in load curves due to rates, type of farming, personal element, geographic location and sales effort expended. It is quite evident that a desirable flat-topped load curve with its accompanying lower overhead service costs can be best attained by wide diversity. This diversity is aided by the development of the different types of farm loads and the finding of new uses for electricity.

Statistics on Rural Electrification in the United States

State	Number of all farms 1930	Farms served 1930	Kw.-hrs per farm per customer, 1929	Average bill per 1930	Number of farms using motors	Number of individual plants, 1930	Farms Served 1923	Farms Served 1932	Per cent served, of all farms, 1932
Total United States	6,288,648	649,919			256,663	249,342	177,561	705,075	11.2
Maine	39,006	13,001	488	$45.60	5,447	1,854	5,676	13,054	33.4
New Hampshire	14,906	5,656	550	61.20	1,561	996	2,396	6,669	44.7
Vermont	24,898	6,986	586	51.75	2,358	1,054	2,384	7,758	31.2
Massachusetts	25,598	14,088	1,012	76.00	4,266	2,057	2,440	14,392	56.2
Rhode Island	3,322	1,811	616	95.20	646	241	400	1,892	59.7
Connecticut	17,195	8,452	586	84.10	2,514	1,200	2,626	9,088	52.9
Total New England	124,925	48,996	684	65.50	14,792	7,402	15,922	52,923	42.4
New York	159,806	47,147	623	63.80	16,012	10,272	16,000	52,004	32.5
New Jersey	25,378	11,212	737	85.90	4,102	2,459	1,000	12,335	48.6
Pennsylvania	172,419	37,983	803	61.50	12,197	10,357	12,918	42,420	24.6
Total Middle Atlantic	357,603	96,342	706	65.50	32,311	23,088	29,819	106,759	29.9
Ohio	219,296	43,242	782	51.20	14,000	16,377	16,803	46,573	21.2
Indiana	181,570	20,503	617	48.90	7,795	11,579	5,228	22,659	12.5
Illinois	214,497	22,699	743	65.00	10,452	15,206	2,201	27,138	12.7
Michigan	169,372	29,869	710	51.60	10,285	8,895	2,996	36,511	21.6
Wisconsin	181,767	34,800	891	69.20	22,812	14,815	7,429	37,541	20.7
Total East No. Central	966,502	151,113	774	57.20	65,344	66,872	32,657	170,421	17.6
Minnesota	185,255	13,121	730	68.90	11,721	10,740	3,339	14,024	7.6
Iowa	214,928	29,634	687	64.50	17,277	19,976	11,237	31,473	14.6
Missouri	255,940	14,418	789	48.20	5,580	7,568	2,913	16,635	6.5
North Dakota	77,975	1,711	783	86.90	3,203	4,426	114	1,835	2.4
South Dakota	83,157	2,846	723	71.90	3,285	6,465	483	2,979	3.6
Nebraska	129,458	8,960	841	74.60	5,807	13,276	790	9,660	7.5
Kansas	166,042	11,593	990	57.70	5,101	10,372	900	13,046	7.9
Total West No. Central	1,112,755	82,283	776	63.20	49,972	72,823	19,776	89,652	8.1
Delaware	9,707	1,163	895	87.00	384	441	105	1,318	13.6
Maryland	43,307(*)	6,614	880	71.60	2557	2,856	1000*	7,095	16.4
District of Columbia		66	1,492		7	13	0	71	68.3
Virginia	170,610	10,105	938	60.70	2427	4,579	2100	12,280	7.2
West Virginia	82,641	2,891	454	54.20	884	2,471	215	3,410	4.1
North Carolina	279,708	9,450	490	45.90	1633	6,022	2100	9,847	3.5
South Carolina	157,931	3,493	554	47.75	757	2,962	900	3,723	2.4
Georgia	255,598	4,378	833	57.70	968	3,895	137	6,171	2.4
Florida	58,966	4,385	920	78.30	1,592	2,143	353	5,165	8.8
Total South Atlantic	1,058,468	42,539	742	59.90	11,209	25,382	6,910	49,080	4.6
Kentucky	246,499	6,815	598	55.20	1,121	4,581	3,411	8,274	3.4
Tennessee	245,657	7,585	535	50.10	1,216	5,182	1,350	8,032	3.3
Alabama	257,395	12,001	895	51.00	678	1,343	1,000	12,478	4.8
Mississippi	312,663	3,548	1,538	74.10	494	2,305	500	3,163	1.0
Total East So. Central	1,062,214	29,949	753	55.00	3,509	11,411	6,261	31,947	3.0
Arkansas	242,334	3,202	196	115.00	1,059	2,196	500	2,976	1.2
Louisiana	161,445	2,218	5,173	123.50	510	2,225	275	2,798	1.7
Oklahoma	203,866	4,517	717	67.75	1,688	3,913	1,600	5,342	2.6
Texas	495,489	11,501	3,008	86.55	4,051	12,299	2,100	11,537	2.3
Total West So Central	1,103,134	21,438	2,335	90.75	7,305	20,633	4,475	28,653	2.1
Montana	47,495	2,192	1,366	79.75	1,088	1,536	550	2,680	5.6
Idaho	41,674	12,186	1,932	62.60	4,406	1,353	5,050	12,418	29.8
Wyoming	16,011	476	1,234	103.00	315	677	280	515	3.2
Colorado	59,956	6,757	761	64.60	2,289	2,845	1,118	7,089	11.8
New Mexico	31,404	1,242	1,299	106.20	393	556	250	1,326	4.2
Arizona	14,173	3,805	1,868	251.00	1,427	228	225	4,682	33.0
Utah	27,159	15,062	853	37.60	1,869	1,224	3,330	15,569	56.6
Nevada	3,442	876	1,152	69.50	564	236	125	949	27.6
Total Mountain	241,314	42,536	2,596	71.40	11,751	8,655	10,928	45,026	18.7
Washington	70,904	33,803	2,675	63.50	10,751	5,800	13,400	36,344	51.3
Oregon	55,153	15,767	2,130	53.20	6,043	2,704	5,250	16,554	30.0
California	135,676	85,153	14677	195.50	43,676	6,572	32,064	83,716	61.7
Total Pacific	261,733	134,723	9,250	147.50	60,470	13,076	50,714	136,614	52.2

* Includes District of Columbia

The accompanying table (P. 18) gives figures on the number of farms served in 1923, 1930, and 1932, and average kilowatt-hours used per farm, the average bill paid per farm, and the number of individual farm lighting plants in use in 1930. On March 31, 1933 there were 706,115 farms receiving central station service, and additional farms were being served at the rate of about 125 per month.

While the South Atlantic and East South Central groups of States have relatively small percentages of farms connected, the increase in the percentage connected in the past few years is relatively large.

The average farm customer in the United States paid $81.40 for his electric service in 1929. This is not a large sum in comparison with expenditures for other kinds of power but is sufficient to indicate a genuine interest in electric service.

Rural Uses for Electricity Other Than on Farms

In recent years electricity has been in demand for a number of rural applications other than on the farm. They include:

Rural churches - lighting and cooking
Rural schools - " " "
Lodge halls - lighting and cooking
Eating places - lighting, cooking, refrigeration, fans, and appliances
Stands and stores - refrigeration, inside and display lighting
Gasoline service stations - pumps, compressors, lighting, and signs
Garages - compressors, tools, pumps, and lights
Auto camps - lights, signs, water systems
Amusement and recreation places - light and small power
Feed mills - cleaning, grinding, elevating and mixing grain, lights
Crop processing plants including hay, grain, fruit, nut, and cotton dehydrators; canneries; and cotton gins - all using power, heat or light
Small manufacturing plants including saw mills and lumber manufacturers - using power and light
City or town water pumping plants with electric pumps
Quarries and gravel pits - lights and power
Radio broadcasting stations - power and lights
Airports - lights, beacons, small power.

Development in Foreign Countries

The information under this heading is indicative of the general trend and widespread interest in rural electrification throughout the world. It is not a complete record of foreign developments, nor is it entirely up-to-date.

Canada.- Special encouragement has been given to rural electrification in the Province of Ontario. Power is generated and distributed by the Province. The provincial government assumes 50 per cent of the cost of transmission lines, transformers, and distribution lines used in serving rural territory. Investments are tax free. Rates include a service charge and an energy charge. The monthly service charge increases with increasing demand. The energy charge is in 2 steps, and varies in different rural power districts, the lower step usually reaching 2 cents per kw.-hr. Some rural rates in the United States are higher and some are lower than those in Ontario. The Provincial Government also has a Rural District Loan Act which provides funds to be loaned to farmers for the purchase of electrical equipment, repayment to be made in five years in monthly installments. Problems of distribution and farm use of power in Ontario and in the United States are quite similar except as affected by special legislation.

Great Britain.- Several societies in Great Britain, including the Royal Agricultural Society and the Institution of Electrical Engineers, have taken an active interest in rural electrification. The first of these activities dates back to about 1924. The British Ministry of Agriculture has had an active committee on electro-culture which has issued many progress reports. Recently the Rothamsted Experiment Station has been supplied with a large number of electrical appliances and an

agreement entered into whereby the Station will make comparative studies and tests of the equipment. Various efforts have been made with some success to supply all residents within rather large areas with electricity. The County Council of Dumfries, Scotland, has recently attempted such a development. Nearly 300 miles of high-tension lines were built in 1932-33 to serve the towns and villages, and it is expected that 300 farms will be connected. Government aid has not been extended as much in Great Britain as on the Continent, and service to farms has been developed more slowly. England's greatest contribution to rural electrification is R. Borlase Matthews, engineer, owner of a 600-acre electrified farm, experimenter, enthusiast, author of the book Electro-Farming, and a prolific writer on rural electrification subjects.

Australia and New Zealand.- Several States in Australia have State Electricity Commissions which supply electricity to urban and rural residents and conduct investigations on the agricultural use of electricity. Farmers in both Australia and New Zealand are making extensive use of electricity particularly in the dairy industry. Both countries in advertising for farm residents have placed especial emphasis on the availability of electricity as an agricultural asset. Power is generated and distributed by the Government or local power boards. In some instances these boards also assist with the financing of electric farm equipment purchases.

Continental Europe.- Perhaps the greatest development of farm electrification has taken place in the central and northern countries of Europe. The development is still in progress. Switzerland with its water power plants leads all other countries in the percentage of homes receiving electric service. Many European farmers use electricity

for lights and for small power purposes about the farmstead such as for root-slicing, chaff cutting, milling, separating, churning, and threshing.

Fifty per cent of the farms in Denmark were reported as being electrified in 1923. Standards of living are higher, more farms are owned by the operators, and farming is more intensive in Denmark than in much of Europe. Electricity is supplied largely through cooperative associations, the Government giving aid in only limited areas. Many of the generating stations are Diesel engine driven.

Finland has numerous water power plants. Most of them financed cooperatively or by joint-stock companies. In 1925 something less than 40 per cent of the farms had electric service.

In Belgium the British Department of Overseas Trade reported, good progress was being made in rural electrification. In November 1931 there were only about 150 parishes not having an electricity supply, and nearly all the rural dwellings capable of being wired were at least provided with electric lights.

Italy has experimented with agricultural uses of electricity for over 35 years. In the valley of the Po electricity is used extensively for reclamation, irrigation, threshing and lesser power applications. Some electric plowing has been done with cable type outfits and recently an electric tractor has been placed on the market. Since the war, the Italian government has offered subsidies to companies constructing power plants and distribution facilities to supply agricultural needs, and special subsidies for irrigation developments which would increase the acreage of crop land. Some progress has been made in investigational work and in cooperative organization for the distribution of electricity and purchase of electrical equipment.

In Germany it has been estimated, sixty percent or more of the farm homes had central station electric service in 1927. In some sections of Germany where farms are small, the farm buildings of a number of farms are grouped together and at some distance from the land. Such farms are easy to serve. Farms in other sections of the country are located at greater distances. There are numerous "power cooperatives" in Germany that buy electricity in bulk from Government or private generating stations and distribute it to members. Before the war the Government gave some aid through indirect subsidies in the form of cheaper credit than was extended to other organizations. Uses for electricity on farms are similar to those in the United States with the addition of threshing, more feed-preparing equipment, and machines used in distilleries. The English journal "Rural Electrification" reports that German companies have made a vigorous effort to increase the rural load and have done "an enormous amount of constructional work" in the past few years.

Rural electrification in Sweden and Norway has attracted considerable attention in the United States largely because of the development of electric soil-heating which had its inception in those countries. Many acres of land devoted to hotbeds and gardens are now electrically heated, some of the installations being well within the Arctic Circle.

Sweden's water power is in part developed by private enterprise and partly by the State. The Board of Waterfalls controls the State developments and aids with the utilization of the countries' power resources. Rural distribution is effected by cooperative distribution societies. Distribution costs are financed by loans to the cooperatives

from savings banks, etc. Rural electric development was rapid and a large part of the arable land is now electrified. It has been estimated that 50,000 grain threshers are driven by electric power. Seed cleaning, chaff cutting, cake crushing, milking, and separating are other common power uses.

In France are 36,000 communes, and half of the population is rural. In 1927, 45 per cent of the communes had electric service; in 1930, 71 per cent were served. The State gives aid to electrification projects in four ways: (1) engineering and technical skill; (2) subsidies for construction; (3) remission of taxes to encourage private construction; (4) loans at low interest rates. The State also carries on an educational campaign to acquaint farmers with the value of using electricity. State subsidies may amount to 50 per cent of the cost or more. Up to December, 1928, the State had distributed $28,000,000 in such grants, which are under the control of the Rural Engineering Service of the Ministry of Agriculture. Subsidy allotments were increased in 1930 from 250,000,000 to 350,000,000 francs. In addition, 700,000,000 francs had been loaned up to November, 1929. Frequently the public utility is itself a syndicate of interested parishes.

Japan.- In 1923 a Farm Electrification Society was organized in Japan with former Premier Kiyoura as honorary President and the former head of the Department of Agriculture as president. A campaign of education was initiated, experts being sent on tours through the country to lecture and demonstrate. Applications were similar to those in other countries, with special emphasis on threshing, drainage and

irrigation, and the addition of silk worm raising and rice hulling. Electricity is supplied by private companies whose development has been quite similar to that in the United States.

China.- This country also has its rural electrification projects. Very interesting reports of experimental work, of an agricultural survey, and of farm uses for electricity have been issued by the Foochow Electric Co., Ltd. While the expenditure for power by residents of Kekung Village, which was reported, is small per patron the expenditure represents a relatively large proportion of the patron's total cash income. Much attention is given by the company to the social and educational betterment of the community.

Summary.— There appears to be a surprising chronological and technical coordination in the development of rural electrification throughout the world. Resulting in part from the World War, this movement came into full swing in most countries between 1923 and 1925. Problems and accomplishments throughout the world have been similar. Records of developments are not complete for the past few years, but comments in foreign publications on conditions have been so similar to our own as to apply almost interchangeably.

Rural electric development in Europe has been more rapid than in the United States probably because of Government aid and encouragement. Most European governments have provided educational assistance and subsidies in one form or another. Cooperative organizations for the distribution of power have been encouraged, and perhaps over-stimulated in some instances. The State frequently owns power plants and sells power.

Rates charged for power range from 1¢ to 20¢ per kw.-hr., which are comparable to rates in the United States. Frequently the service voltage is 220-380 instead of 115-230 as in the United States, with accompanying lower costs of distribution.

Motor applications are usually below 5 hp. except where a number of farmers cooperate in such operations as threshing, in which case 30-hp. motors are not uncommon. Electric threshing has been developed to a much greater extent in European countries than in the United States. Electric plowing with very large cable-drawn plows is being practiced to some extent in France, Germany, and Italy, and keen interest in field operations exists throughout Europe, whereas they have had little support in this country.

Europe has many small farms but it also has a large number of farms of 50 to 100 acres with cultural problems similar to our own. Reports from most countries indicate that the farmers everywhere have been relatively slow to try new equipment and methods. Rural electrification has slowed down at present because farmers in practically all countries are finding difficulty in making their incomes cover their obligations.

There has been little progress in the decentralization of industry although a few attempts have been made.

Present Status of Rural Electrification

Farm, utility, and political interest in rural electrification has been rather generally aroused throughout the world. Farm demand has been created and distribution lines have been extended to those rural areas easiest to serve. Rural use of power is building up gradually. Farm applications have been largely on a hit-and-miss basis, governed by sales enthusiasm and resistance rather than by orderly planning or premeditated economic design. To the farmer electricity has meant good light without smoked chimneys, a care-free radio, and a few city conveniences. To the utility it has been a possible source of future sales profit. Utility executives have given support to educational programs on a chance and policy basis, and without enthusiasm commensurate with the potential sales field. Investigations have dealt largely with possible substitutions of electricity for some other source of power, light or heat.

Some farm machines such as feed grinders and silo fillers have been redesigned for electric drive and greatly improved. Effective farm refrigeration with accompanying improvement in dairy and other farm products has been made possible. A few new uses for electricity have been developed. They include soil heating for plant production, and the use of light and other electric rays for stimulating winter egg production, flowering of plants, and health of animals. The greatest opportunities for the utilization of electric energy — namely, field and tractive operations and insect and disease control — have scarcely been sounded. While electricity has found many unique uses in medicine and surgery and in industry, its application to the complex problems of plant and animal growth and bacterial life has scarcely appeared in the programs of agricultural research.

The easy jobs of applying electricity to agriculture have been done. The occasional farm unit or group of farms where electricity has been combined with good management and a definite economic program promise much more for the future of rural electrification than has been achieved. Most of the hard problems are still ahead.

PART III. - A PROGRAM OF RURAL ELECTRIFICATION FOR THE TENNESSEE RIVER BASIN.

In outlining this program, the following assumptions are made:

1. The project is an experiment in promoting the public weal, and as such should not be bound by precedent where deviation from precedent may result in public betterment.

2. The rural electrification program shall have for its primary purpose the aiding of the user rather than the profit or safeguarding of the seller of electricity.

3. Any progress made in rural electrification within the Tennessee River Basin will be of direct benefit to rural users and to sellers of electricity outside the Basin.

Project 1: Policy.

Obtain decisions on the following:

a. Will the government build distribution lines?

b. Will the government sell power direct to farmers?

c. Will the government grant subsidies or loans to farmers for line construction, farm wiring, or purchase of electric utilization equipment?

d. Will the government promote rural or urban industries which may change the character of local agriculture or the uses for electricity?

The answers to these questions of policy will be involved in other projects on distribution network, rural rates, etc.

Project 2: Distribution Network.

a. Appraise the probable need and desire for rural service at the end of a development period of, say 10 years.

b. Ascertain the location, capacity, type of construction, state of repair, and ownership of existing distribution lines.

c. Contact existing distribution agencies and learn their attitude toward rural distribution, rates, line extension policies, and cooperation with the Tennessee Valley Authority.

d. Investigate the possibility of sharing distribution line costs with rural industries and construction jobs requiring power.

e. Establish a rural line extension policy.

f. Plan a distribution network which could be built in progressive units.

g. Organize farm groups for the construction of distribution lines and purchase of power.

After becoming familiar with the territory and people through personal contacts and observation of the territory, this would be largely an office project based upon agricultural and population statistics, utility information, and a knowledge of developments in rural electrification under educational guidance and promotional activity. A study of cooperative line construction and power distribution organizations in Europe through diplomatic or other channels might be helpful. Farm group organization, if adopted, could probably be effected in cooperation with existing government educational agencies.

Project 3: Design of Distribution Lines.

Present rural distribution lines are urban lines transplanted in the country. They have resulted from precedent in urban practice and from the engineer's sense of propriety in the use of materials and labor rather than from fulfillment of an economic need of rural territory.

Cost of line construction plays a much larger part in service costs into the country, where users are scattered, than it does in the city. Rural distribution costs are greater than generating costs and should have equal or greater attention.

This project would attempt the following:

a. Set up the economic and physical requirements of rural lines.

b. Study prevailing and new designs for distribution lines, giving particular attention to departures from usual construction and to present practice in the Tennessee River Basin. Investigate higher distribution voltages.

c. Ascertain availability of local materials that might be used for construction.

d. Design low cost distribution line with quick repair features for minimum outages.

e. Investigate the possibility of local repair crews to obviate long outages after storms.

Rural lines usually cost from $1200 to $2000 per mile. A farmer, owner of a small rural distribution system in Oregon, built a novel type of line for less than $350 per mile. Some of these lines have been in use more than ten years. There are possibilities for someone who understands farmer's problems and does not know too much about line construction to make a real contribution to rural service.

Project 4: Rural Rates.

Most of our present rural rates are complex, and hard to understand and apply. They place penalties on increased uses, and they have so many conditions and options and vary so widely from the adjoining company's rates that they establish distrust and discourage use. The reason is probably that rate engineers are trained to deal with figures rather than human beings. The rate structure reflects the ability of the expert to work out a rate formula, including the multifarious items of cost, which will protect the utility from any possible loss, — whether it discourages the use of the service or not.

A rural rate should be simple. It's first requirement should be that it interests the customer in using electricity — and more of it, and at the same time enables the utility to sell electricity — and more of it. Where fear of loss has been replaced by desire to serve, and unintelligible rates by simple ones of the promotional type, the results have been increased use and a reduction in accounting and service costs, and no loss of profit.

The work of this project would be to —

a. Outline the features of a rate structure which would be most acceptable to the rural user and encourage his use of service.

b. Check this structure against existing rates and the response to them as indicated by actual use or complaints of farm customers. (Data might be secured from utilities having rural service departments, from published articles, etc.)

c. Assign values to rate blocks to apply throughout the Basin or in different sections of the Basin. Values to be determined by the Tennessee Valley Authority in cooperation with distribution agencies.

d. Study results of the application of simple rates, and compare with returns under more complicated rate structures.

e. Study factors affecting rates, including single and multiple metering; flat rates for specific service; daily, monthly and annual load factors; diversity factors; line and transformer losses. These studies shall be for the purpose of finding means of further improvement in rates and not to determine penalties or charges to be added.

Project 5: Farm and Residence Wiring.

Work out a system or systems of wiring which can be recommended particularly for use in buildings which have been constructed, and based on the user's interests in

a. economy,

b. safety,

c. adequacy, and

d. future expansion.

Investigate present and proposed wiring systems, including the grounded return system using concentric wiring. Study load centers, and entrance and meter locations, outdoor switching and metering, and means for adequate grounding. Make experimental wiring installations, work for electrical code reforms which will simplify wiring. Conduct contractors' wiring schools and wiring demonstrations to aid in improving wiring and lowering costs. Prepare farm wiring contract forms to be recommended.

Project 6: Financing.

Some method of helping farmers to finance the wiring of premises and purchase of equipment for utilizing electricity will be necessary if a load is to be built up fast enough to make low rates feasible. The system adopted by the Ontario Hydro Commission and by some utilities in the United States might be adapted to local conditions.

Project 7: Foreign Developments.

Certain phases of rural electrification — namely: cooperative distribution companies, financing and subsidies, and electric plowing — have developed faster in other countries than in the United States. A study of methods and results either through United States representatives in those countries or by visits to the several countries might save costly local experiments.

Project 8: Utilization of Electricity on the Farm.

This project would be a combination of research and demonstrations. It can be put into effect at once and may be conducted on either a small or a large scale. It would involve —

a. A study of local farm conditions and uses for electricity adaptable to those conditions.

b. Selection of representative farms using electricity advantageously and on which attention might be focused through agricultural extension forces.

c. Educational demonstrations at meetings, on farms, or on demonstration trucks or trains, exhibiting and teaching methods of using electricity profitably in the farm business and in the home. Such demonstrations might include good lighting, economical wiring, feed grinding, hotbed heating, brooding, water supply, small motor applications, care of electrical equipment, etc.

d. An Authority demonstration and research farm (see Project 10).

e. Authority Model Electrified Farms. The Authority would set aside a revolving fund of $100,000 to be used for purchasing and equipping of model farms of the type to be recommended in different sections of the Basin. These farms would be sold on amortized payments to carefully selected operators with the understanding that the farms were to be demonstrations of well planned and well managed electrified farms. The prospective owner would be employed to aid in the planning and development of his farm. The farms would not be elaborate, but the layout, buildings, and equipment would be planned for efficient operation, esthetic values, home comfort, and the best possible return on the investment. A special effort would be made to reduce overhead costs on these farms by increasing the annual hours of use of equipment and machines. Additional farms could be established as fast as the original investment was returned. The Authority would retain a supervisory interest in the farms until payments were made in full.

f. Farm Engineering Management Advisory System. It is assumed that the introduction of a new source of power having the possibilities of electricity will eventually necessitate changes in farm organization and management the same as did the gas tractor. Electric poultry brooding and electric sterilization of dairy utensils, for instance, call for different housing and management than non-electric methods. As fast as specific information on these enterprises is obtained it should be put into the educational extension channels in the Basin.

Project 9: Supplemental Industries.

a. Investigate the possible rural industries and businesses other than farming which might use power. How can they be made to assist in carrying the cost of rural lines?

b. Can small or decentralized industries be attracted to the small towns or rural territory to give part time employment to farmers?

c. Can any cottage or supplemental farm industries be developed if power is available at low cost on the farm?

These subjects would call for some research in the light of existing and prospective conditions in the Tennessee Basin.

Project 10: Research in Farm Use of Electricity.

a. An Authority Research Farm completely equipped electrically for farming and all kinds of electrical research pertaining to agriculture. This farm would be a show place and educational demonstration, in that it would use no power except electricity

and every conceivable use for electricity on farms would be on display. It would be a place to try out new ideas and new equipment and to develop new farm processes for utilizing electricity. It would be headquarters for rural electrification work in the Basin. It would be a source of publicity, -- an essential adjunct to arousing interest in new developments.

Buildings on this farm would not conform to present standards of arrangement, design, construction, wiring, etc., but would be planned for efficiency and would incorporate unconventional ideas where these might reduce costs, improve methods, or enhance the use of electricity.

Research projects would be conducted in cooperation with existing agencies in the Department of Agriculture and State Experiment Stations in order to keep the research staff as small as possible.

Studies which might be undertaken include --

(1) Use of electricity for field power.

(2) Physiological and biological effects of electrical discharges and various waves and rays on soils and on plant and animal life.

(3) Insect and pest control.

(4) Electric light and heat for stimulating plant production and flowering.

(5) Features of organization and management peculiar to electrified farms and farm homes, — a combination of research and field studies on model and other farms. This study contemplates changes analogous to what occur in factories when changes are made from steam power to individual electric drive or from coal heat to electric heat in alloy furnaces or tempering.

(6) Economic and social development possibilities resulting from rural electrification.

(7) Local problems such as accelerated tobacco curing, sweet potato storage, etc.

b. Research Scouting. There are many research, investigational, or development projects being worked on in public and private laboratories throughout the country. Some of these have no bearing on rural electrification so far as the research worker is concerned, but when properly interpreted or applied may form the basis of a new concept or application for electricity. These developments may take place on farms, or be student problems or hobbies of some research man whose work is neither published or listed as research work of an institution. They are only discovered through many personal contacts. In a subject as new as the agricultural application of electricity, such contacts are valuable.

A hasty survey of research activities was made by the C.R.E.A. in 1930 and published in June, 1931. (Report on Farm Electrification Research by Geo. W. Kable, C.R.E.A. Vol. VI, No. 1.) A soil-heating survey was made in 1931 and was followed by national publicity and a rapid development of electric soil heating. This work is not being carried on by any agency at the present time. To be most effective it should be followed up to learn the results of such studies as that of the effect of changing the polarity of electric charges on pollen grains, made at Pennsylvania State College, and to stimulate interest in further research or trial to fill in the gap between fundamental research and practical application.

One man could spend full time on this project for a few years. Reasonably effective work could be done with as little as one-fourth the time of one man.

Cooperation.

There are several existing agencies which might cooperate effectively in carrying out the foregoing program. Most of the program lies within the field of the Bureau of Agricultural Engineering. Other problems are in the fields of agricultural economics and home economics. The Extension Service of the Department of Agriculture should be effective in carrying the program to the farmers, and some of the research problems might be undertaken at agricultural experiment stations of states within the Basin. Local power companies purchasing power from government plants might also be interested in the development work.

APPENDIX A.- USE OF ELECTRICITY ON FARMS IN TENNESSEE RIVER BASIN

(Only counties with one-half or more of area in the basin are included, and figures shown are for entire counties. Based on Census of 1930)

State and county 1/	All farms in basin				Farms using electricity				
	Number	Tenant farms	Average size	Predominating types 2/	Electric lights	Electric motors	Central station service	Amount of bills for current 3/	Individual lighting plants 4/
			Acres					Dollars	
Total for basin(counties listed)	229,982	94,700			5/ 10,178	819	6,902	285,769	3,278
Average per farm			73.4					41.40	
Alabama:									
Colbert	2,904	2,074	62.5	C.U.and S.S.	45	8	18	858	27
De Kalb (1/2)	6,586	3,465	57.2	C, S.S.and G.	180	7	145	3,791	35
Franklin	3,429	1,955	68.8	C, G. and S.S.	67	2	40	1,450	27
Jackson	5,337	3,209	71.6	C, S.S, and G.	65	7	30	1,189	35
Lauderdale	5,246	3,298	56.3	C., G., and S.S.	102	9	37	1,003	65
Lawrence	5,119	3,758	53.7	C., U., and S.S.	57	7	29	1,045	28
Limestone	6,349	4,711	46.5	C., S.S. & U.	104	18	47	2,648	57
Madison	7,178	5,424	54.0	C., G. and S.S.	182	34	108	7,979	74
Marshall	6,279	3,688	48.2	C.,G., and S.S.	145	8	71	2,278	74
Morgan	5,079	3,285	55.1	C.,S.S. & G.	189	5	145	3,946	44
Total	53,506	34,867			1,136	105	670	26,187	466
Averages per farm			56.3					39.08	
Georgia:									
Catoosa	974	462	79.9	C.,G., and T.	29	1	10	1,746	19
Dade	486	203	93.3	S.S., C., & G.	4	-	-	-	4
Fannin	1,472	473	88.7	S.S., P.T.& G.	64	-	52	1,131	12
Towns	663	230	72.1	S.S., G. & P.T.	12	-	3	51	9
Union	1,117	399	90.0	S.S.,G. & U.	5	1	1	30	4
Walker (1/2)	2,370	1,135	76.8	C.,S.S., & G.	98	11	37	2,482	61
Total	7,082	2,902			212	13	103	5,440	109
Averages per farm			82.4					52.82	
Kentucky:									
Calloway	2,990	958	72.2	C.S., G., & S.S	80	7	47	1,498	33
Marshall	2,417	768	70.4	C.S.,G., & S.S.	26	-	2	48	24
Total	5,407	1,726			106	7	49	1,546	57
Averages per farm			71.4					31.55	
Mississippi:									
Tishomingo	2,534	1,344	70.1	C.,S.S., & G.	52	1	48	1,547	5
Averages per farm								32.23	

1/ Figures in parentheses indicate, for counties partly outside of basin, the portions of area inside the basin.

2/ Types of farms indicated thus: A.S., animal specialty; C, cotton; C.S., crop specialty; D, dairy; F, fruit; G, general; P.T., part time; S.S., self sufficing; T, truck; U, unclassified.

3/ Average amounts of bills are averages for farms buying central station service.

4/ Number of individual lighting plants is difference between number of farm dwellings lighted by electricity and number of farms reporting purchase of current from power companies.

5/ Apparently two farmers in Moore County, Tenn. did not have electric lights but bought current for other purposes.

USE OF ELECTRICITY ON FARMS IN TENNESSEE RIVER BASIN (Cont'd)

(Only counties with one-half or more of area in the basin are included, and figures shown are for entire counties. Based on Census of 1930)

State and county 1/	All farms in basin				Farms using electricity				
	Number	Tenant farms	Average size	Predominating types 2/	Electric lights	Electric motors	Central station service	Amount of bills for current 3/	Individual lighting plants 4/
			Acres					Dollars	
North Carolina									
Avery (2/3)	1,410	154	62.1	S.S., P.T.& G.	160	5	122	3,689	38
Buncombe	3,895	962	59.2	S.S., G.,& P.T.	551	62	403	17,104	148
Cherokee	1,958	614	78.9	S.S.,P.T.,& G.	30	1	16	521	14
Clay	898	247	67.4	S.S., G., & U.	22	-	20	417	2
Graham	692	218	69.8	S.S.,P.T., & G	8	-	-	-	8
Haywood	2,125	677	75.4	S.S.,G., & P.T.	140	12	99	3,087	41
Henderson (3/4)	1,983	438	60.6	S.S., G., & P.T	314	35	268	8,222	46
Jackson	2,117	514	62.4	S.S.,P.T.,& G.	142	1	98	2,449	44
Macon	1,847	431	70.6	S.S.,P.T. & G.	55	2	35	1,426	20
Madison	3,267	1,174	62.3	S.S.,C.S., & G	178	8	129	3,722	49
Mitchell	1,887	301	48.4	S.S., P.T.,&G.	257	6	200	4,795	57
Swain	1,174	313	79.6	S.S.,P.T., & G	61	1	44	1,047	17
Transylvania	730	187	86.1	S.S., P.T.,& G	75	15	45	1,349	30
Watauga (1/2)	2,375	452	68.7	S.S., G., & P.T.	117	2	59	2,500	58
Yancey	2,039	467	61.9	S.S.,P.T.,& G.	182	3	137	3,620	45
Total	28,397	7,149	1,013.4		2,292	153	1,675	53,948	617
Averages per farm			65.7					32.21	
Tennessee									
Anderson (2/3)	1,445	342	83.3	S.S.,G., & P.T.	23	-	6	377	17
Bedford	2,801	1,270	101.2	G.,A.S.,& S.S.	230	30	197	6,703	33
Benton	1,751	603	112.7	G.,C.,& S.S.	11	1	3	110	8
Bledsoe (2/3)	927	326	117.0	S.S.,G.,& A.S.	7	1	2	70	5
Blount	2,417	632	81.6	S.S.,G.,& P.T.	167	30	106	9,880	61
Bradley (3/4)	1,780	662	102.0	S.S.,G. & P.T.	140	13	91	3,931	49
Campbell (1/2)	1,754	339	62.8	S.S.,G., & P.T.	73	-	54	1,708	19
Carter	2,348	371	48.8	S.S.,P.T.,& G.	189	18	170	5,718	19
Claiborne (4/5)	3,298	874	56.4	S.S.,G.,& U.	113	7	85	4,214	28
Cocke	2,707	935	72.8	S.S.,G.,& C.S.	53	4	28	1,602	25
Coffee	2,112	850	90.7	S.S.,G., & U.	65	13	24	918	41
Cumberland (3/4)	1,034	169	81.1	S.S.,P.T.,& G.	40	1	30	1,139	10
Decatur	1,654	741	92.9	C,G. & S.S.	34	1	31	605	3
Franklin	2,553	1,085	84.1	S.S.,G.,& C.	157	19	104	3,832	53
Giles	4,811	2,686	71.5	C.,G., & S.S.	102	6	57	5,390	45
Grainger	2,140	598	76.1	S.S.,G.,& C.S.	49	1	37	1,635	12
Greene	5,004	1,617	65.0	C.S.,G.,& S.S.	352	22	264	12,392	88
Grundy (1/2)	524	114	79.1	S.S.,P.T.,,& G	18	6	14	473	4
Hamblen	1,501	474	68.8	G.,S.S., & P.T.	126	4	90	2,511	36
Hamilton	2,407	941	78.7	S.S.,G., & P.T.	238	40	153	8,236	85
Hancock	1,613	481	73.0	S.S.,G.,& C.S.	30	2	4	433	26
Hardin	2,708	1,602	73.6	C.,S.S.,& G.	24	2	24	627	-
Hawkins	3,505	965	73.8	G.,S.S.,& P.T.	242	13	226	6,319	16
Henderson (2/3)	3,290	1,596	82.0	C.,G.,& S.S.	23	-	17	634	6

(for footnote see page 1)

USE OF ELECTRICITY ON FARMS IN TENNESSEE RIVER BASIN (CON'T)

(Only counties with one-half or more of area in the basin are included, and figures shown are for entire counties. Based on Census of 1930)

State and county 1/	All farms in basin				Farms using electricity				
	Number	Tenant farms	Average size	Predominating types 2/	Electric lights	Electric motors	Central station service	Amount of bills for current 3/	Individual lighting plants 4/
			Acres					Dollars	
Tennessee (Continued)									
Henry (1/2)	3,296	1,306	90.6	C.S.,G.,& S.S.	70	11	30	1,083	40
Hickman	1,647	588	118.6	S.S.,G.,& A.S.	26	2	11	222	15
Houston (1/2)	789	291	104.9	S.S.,G., &C.S.	10	1	6	145	4
Humphreys	1,452	615	127.0	S,S., G.,& U.	43	-	31	1,327	12
Jefferson	2,204	796	80.1	G., S.S.,& C.S	124	17	67	3,288	57
Johnson	1,593	194	72.0	S.S., G., & P.T.	90	7	61	2,546	29
Knox	4,039	896	62.8	S.S.,P.T., & G.	526	67	345	26,866	181
Lawrence	3,845	1,935	70.4	C.,G.,& S.S.	96	5	46	1,155	50
Lewis	507	188	114.0	S.S., G., & P.T.	22	-	19	420	3
Lincoln	4,131	2,320	76.6	C.,G., & S.S.	155	10	97	3,848	58
Loudon	1,332	567	98.1	G.,S.S., & U.	52	11	35	2,890	17
McMinn	2,510	816	93.1	S.S.,G., & P.T.	129	10	95	9,155	34
Marion	1,044	325	82.2	S.S.,P.T.,& G.	57	5	39	1,479	18
Marshall	2,297	944	97.5	G.,S.S., & D.	122	7	94	3,271	28
Maury	3,680	1,628	94.0	G.,S.S., & A.S.	254	26	167	8,958	87
Meigs	757	300	161.1	G.,F.,& S.S.	10	1	-	-	10
Monroe	2,800	1,082	81.6	S.S.,G., & U.	93	2	74	2,135	19
Moore	976	480	70.5	G.,A.S., & U.	5/ 10	2	5/ 12	350	0
Morgan (4/5)	1,074	153	83.7	S.S.,P.T., & G.	32	3	19	484	13
Perry	1,070	473	147.6	S.S.,G.,& C.S.	32	-	3	45	29
Polk	1,082	556	90.3	C.,S.S., & G.	43	1	22	705	21
Rhea	1,206	536	98.7	G.,S.S., & F.	62	5	52	1,194	10
Roane	1,304	443	130.3	S.S., G.,& U.	46	3	32	1,287	14
Sequatchie (4/5)	537	141	69.3	S.S.,P.T., & G.	11	-	9	165	2
Sevier	2,931	1,116	76.8	S.S.,G., & U.	81	2	32	1,941	49
Sullivan	3,186	786	65.4	S.S.,G.,& P.T.	179	13	147	4,879	32
Unicoi	860	197	50.4	S.S.,P.T., & G.	38	2	29	1,042	9
Union	1,966	442	65.2	S.S.,G., & U.	30	1	6	667	24
Washington	2,980	679	57.0	G.,S.S.,& C.S.	339	21	278	11,220	61
Wayne	1,635	859	120.2	S.S.,C., & G.	1	-	-	-	1
Totals	114,814	41,925	4679.0		5,289	469	3,675	172,224	1,616
Averages per farm			81.7					46.86	
Virginia									
Lee	2,439	675	75.6	S.S., G.,& P.T.	116	9	40	1,565	76
Russell	2,796	809	97.3	S.S.,G.,& A.S.	135	2	96	3,626	39
Scott	3,791	1,160	67.2	S.S.,G.,& P.T.	31	7	7	258	24
Smyth	1,822	279	99.3	S.S.,P.T.,& G.	149	16	137	5,615	12
Tazewell (2/3)	1,748	318	123.2	S.S.,P.T.,& G.	200	17	101	4,343	99
Washington	3,813	1,127	71.9	C.S.,G.,& S.S.	278	16	176	6,076	102
Wise (2/3)	1,833	419	47.1	S.S.,P.T.,& G.	181	4	125	3,394	56
Totals	18,242	4,787	581.6	S.S.,P.T.,& G.	1,090	71	682	24,877	408
Averages per farm			80.5					36.48	

(For footnote see page 1)

APPENDIX B. - RURAL RATES FOR ELECTRIC POWER IN TENNESSEE RIVER BASIN AND SURROUNDING TERRITORY.

Georgia Power Co. (Since September, 1930)

Rural rate = Standard rate plus line rental charge (Schedule R). Applicable on all rural lines (11,000 v. or less serving less than 20 customers per mile).

Rental charges:- 15 to 20 customers, $ 0.23 per mo.
11 to 15 customers, 1.11 per mo.
6 to 10 customers, 1.66 per mo.
Under 6 customers, $ 13.88 per mi. of line

A-1 rate - 115/230 v., single-phase, under 2 hp.:
Service charge, $ 1.11 per mo. for 25 a. 220 v. total connected
2.22 per mo. for more than 25a, 220v. total connected.

Energy, 50 kw.-hr. at 5.55¢
150 kw.-hr. at 3.33¢
200 kw.-hr. at 2.22¢

B-1 Optional - commercial, cooking, etc., under 2 h.p. of power:
Service charge, $ 2.22 per meter.
Energy charge, 3.33¢ per kw.-hr.

Cotton gins -
Service charge, $ 66.00 per season of 5 mo. plus energy.
Energy, 100 hrs. use of lighting demand at 6.66¢ per kw.-hr.
All above 100 hrs. use of lighting demand at 2.77¢ per kw.-hr.

Alabama Power Co. (Effective September, 1930)

Class "E" - (One meter outside of towns; demand under 50 kw. - Rural line with less than 20 customers per mi.)

Capacity requirements charge (Service)
Over 15 customers per mile, $ 1.50
11 to 15 customers per mile, 2.00
6 to 10 customers per mile, 2.50
Under 6 customers per mile, 3.50

Permitted: House lighting
200 w. other lighting,
8 kw. range,
1½ kw. miscel.

Service charge increased 15¢ per 1/10 kw. above permitted demand.

Alabama Power Co. (Effective September, 1930) (continued)

Class "E" - (continued)

Energy: 50 kw.-hr. at 5¢
950 kw.-hr. at 3¢
1000 kw.-hr. at 2¢

3 printed pages of additional conditions, etc.

Class "A-5" - Adjacent to towns

5 kw.-hr. for $1.25
45 kw.-hr. at 4¢
950 kw.-hr. at 3¢
4000 kw.-hr. at 2¢
over 5000 kw.-hr. at 1¢

Added charges: Room charge - 15¢ per room
$1.00 per hp. in motors
1.00 in excess of 8 kw. of cooking and 2 kw. of heating.

2 other pages of provisions, etc.

Appalachian Electric Power - Va. (All on 3x5 card) (April 1, 1931)

Customer charge of 50¢ per meter per mo.

Energy: 25 kw.-hr. at 6¢
50 kw.-hr. at 4¢
225 kw.-hr. at 3¢
over 300 kw.-hr. at 2¢

Minimum mo. charge (incl. energy) = $1.00 + 50¢ per hp. for each motor above 1 hp.

("Typical for 3 leading cos. in Va." - Seitz)

Carolina Power and Light Co. - (North Carolina)

With 6 or more customers per mi. -
Service - 2½% per mo. of Co's. investment in lines, etc.
Flat charge - $1.00 per mo.
Energy - 5¢ per kw.-hr.

Flat charge (with range) $2.05 for 1st 4 rooms + 10¢ per room.
Energy - 200 kw.-hr. at 3¢
Above 200 kw.-hr. - 2¢

Less than 6 customers per mi. Customers deposit 1/6 of line cost per mile for all under 6 customers. Pay 12½¢ per pole per mo.
Maintenance for customers' share of line.
Service, flat charge and energy as above.

Other rates -

Tennessee Electric Power Co.

Line Costs: Regular urban rates with guaranteed monthly minimum of 2% of line construction cost.

Rate R - Power, general and light, single-phase not less than 3 kw. connected.

Minimum - $3.00
Energy - 40 kw.-hr. at 10.45¢
all over 40 kw.-hr. at 2.85¢

Rate H - Lighting
Minimum - $1.00
Energy - 50 kw.-hr. at 9.5¢
50 kw.-hr. at 6.65¢
all over 100 kw.-hr. at 4.75¢

Rate A - Power. For 15 kw. demand or more.
Demand charge - $1.50 per kw. for first 500 kw. of demand per month;
1.31 per kw. all above 500 kw. of demand per month.

Energy - 500 at 4¢ per kw.-hr.
1500 at 2¢ per kw.-hr.
2500 at 1½¢ per kw.-hr.
down to ½¢ per kw.-hr.

Minimum $39.47 per mo. or $1.58 per kw. per month of minimum demand.

Tennessee Eastern Electric Co.

Construction cost - Minimum monthly bill = 2½% line cost.

Rate A - Domestic only.
First 5 kw.-hr. - $1.10
45 kw.-hr. at 5¢
150 kw.-hr. at 3¢
All over 200 kw.-hr. at 2¢

Rate C-2 - Combination commercial - 10 kw. or more, or with refrigerator or stove.

3-part rate.
Customer charge - $1.00
Reservation charge
per 100w. connected 0.15
Energy 500 kw.-hr. at 5¢
500 kw.-hr. at 3¢
all over at 2¢

Rate F - 2 hp. or more
Demand charge - $1.40 per kw.
Energy - 1600 kw.-hr. at 3¢
8400 kw.-hr. at 1½¢
down to 08¢